**PAAVAI ENGINEERING COLLEGE (AUTONOMOUS)**
**B.E. SAFETY AND FIRE ENGINEERING**
**REGULATIONS – 2019 (CBCS)**
**CURRICULUM**
**SEMESTER V**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | PC | SF20501 | Manufacturing Technology | 3 | 0 | 0 | 3 |
| 2 | PC | SF20502 | Quality control and Reliability Engineering | 3 | 0 | 0 | 3 |
| 3 | PC | SF20503 | Chemical Technology and Reaction Engineering | 3 | 0 | 0 | 3 |
| 4 | PC | SF20504 | Design of Fire Fighting and Protection System | 3 | 0 | 0 | 3 |
| 5 | PC | SF20505 | Chemical Process Safety | 3 | 0 | 0 | 3 |
| 6 | PC | SF20506 | Heat and Mass Transfer | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | SF20507 | Manufacturing Technology Laboratory and Introduction to CAD | 0 | 0 | 2 | 1 |
| 8 | PC | SF20508 | Unit Operations Laboratory | 0 | 0 | 2 | 1 |
| 9 | EE | EN20501 | Career Development Laboratory I | 0 | 0 | 2 | 1 |
| **Total** | | | | **18** | **0** | **6** | **21** |

**SEMESTER VI**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | PC | SF20601 | Legal Aspects of Health Safety and Environment | 3 | 0 | 0 | 3 |
| 2 | PC | EE20607 | Process Control and Instrumentation | 3 | 0 | 0 | 3 |
| 3 | PC | SF20602 | Hazard Control in Manufacturing Industry | 3 | 0 | 0 | 3 |
| 4 | PE | SF2015* | Professional Elective-I | 3 | 0 | 0 | 3 |
| 5 | PE | SF2025* | Professional Elective-II | 3 | 0 | 0 | 3 |
| 6 | OE | SF2090* | Open Elective-I | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | SF20603 | Environmental Engineering Laboratory | 0 | 0 | 2 | 1 |
| 8 | EE | SF20604 | Design and Fabrication Project | 0 | 0 | 4 | 2 |
| 9 | EE | EN20601 | Career Development Laboratory II | 0 | 0 | 2 | 1 |
| **Total** | | | | **18** | **0** | **8** | **22** |

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Safety and Fire Engineering
17/5/24
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## LIST OF ELECTIVES

### PROFESSIONAL ELECTIVE – I

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| HAZARD MANAGEMENT AND SAFETY STANDARD | | | | | | | |
| 1 | PE | SF20151 | Industrial Engineering | 3 | 0 | 0 | 3 |
| 2 | PE | SF20152 | Safety Management | 3 | 0 | 0 | 3 |
| 3 | PE | SF20153 | Hazard Analysis and Risk Assessment | 3 | 0 | 0 | 3 |
| 4 | PE | SF20154 | Fire Safety Codes and Standardization | 3 | 0 | 0 | 3 |

### PROFESSIONAL ELECTIVE – II

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| FIRE SAFETY SYSTEMS | | | | | | | |
| 1 | PE | SF20251 | Fire Engineering | 3 | 0 | 0 | 3 |
| 2 | PE | SF20252 | Fire Risk Analysis and Accident Investigation | 3 | 0 | 0 | 3 |
| 3 | PE | SF20253 | Fire Fighting Installation and Automation | 3 | 0 | 0 | 3 |
| 4 | PE | SF20254 | Fire Prevention and Protection Measures | 3 | 0 | 0 | 3 |

### OPEN ELECTIVE – I

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | OE | SF20901 | Energy Conservation and Management | 3 | 0 | 0 | 3 |
| 2 | OE | SF20902 | Air Pollution and Control Engineering | 3 | 0 | 0 | 3 |

| SF20501 | MANUFACTURING TECHNOLOGY | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | illustrate the working principles of various metal casting processes |
| 2. | learn and apply the working principles of various metal joining processes |
| 3. | analyse the working principles of bulk deformation of metals. |
| 4. | discover the fundamentals of the sheet metal forming process. |
| 5. | study and practice the working principles of plastics molding. |

| UNIT I | METAL CASTING PROCESSES | 9 |
|---|---|---|

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications–Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – $CO_2$ casting — Defects in Sand casting process-remedies

| UNIT II | METAL JOINING PROCESSES | 9 |
|---|---|---|

Fusion welding processes – Oxy fuel welding – Filler and Flux materials—Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electro slag welding– Plasma arc welding — Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection &remedies – Brazing - soldering – Adhesive bonding.

| UNIT III | BULK DEFORMATION PROCESSES | 9 |
|---|---|---|

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations.

| UNIT IV | SHEET METAL PROCESSES | 9 |
|---|---|---|

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

| UNIT V | MANUFACTURE OF PLASTIC COMPONENTS | 9 |
|---|---|---|

Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff moulding.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | explain the principle of different metal casting processes. | Understanding (K2) |
| CO2 | describe the various metal joining processes. | Understanding (K2) |
| CO3 | illustrate the different bulk deformation processes. | Understanding (K2) |
| CO4 | apply the various sheet metal forming process. | Applying (K3) |
| CO5 | utilize an appropriate molding process while producing plastic components. | Applying (K3) |

**TEXT BOOKS**

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,4th Edition, 2019
2. P.N .Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition, 2018.

**REFERENCES**

1. Ro y. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, Reprint, 2019.
2. S. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2018.
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Eligth Edition, Materials and Processes, in Manufacturing, Eight Edition, Prentice – Hall of India, Reprint, 2017.
4. Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II,

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | - | 2 | - | - | 2 | 3 | 1 | 1 | - | - | 1 | 2 | 1 |
| CO2 | 3 | 2 | 2 | - | - | 2 | 3 | 1 | 1 | - | - | 1 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 2 | - | 2 | 2 | 1 | 1 | - | - | 1 | 2 | 1 |
| CO4 | 3 | - | 2 | 2 | - | 2 | 2 | 1 | 1 | - | - | 1 | 2 | 1 |
| CO5 | 3 | - | 2 | - | 2 | 2 | 2 | 1 | 1 | - | - | 1 | 2 | 1 |

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| SF20502 | QUALITY CONTROL AND RELIABILITY ENGINEERING | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | introduce the concept of SQC. |
| 2. | understand process control and acceptance sampling procedure and their application. |
| 3. | learn the concept of reliability. |
| 4. | gain knowledge on Life testing concept |
| 5. | become familiar with the concept Reliability and the techniques involved |

| UNIT I | INTRODUCTION AND PROCESS CONTROL FOR VARIABLES | 9 |
|---|---|---|

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart-uses of control chart –X chart, R chart and chart - process capability – process capability studies and simple problems. Six sigma concepts.

| UNIT II | PROCESS CONTROL FOR ATTRIBUTES | 9 |
|---|---|---|

Control chart for attributes –control chart for non-conforming – p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

| UNIT III | ACCEPTANCE SAMPLING | 9 |
|---|---|---|

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

| UNIT IV | LIFE TESTING – RELIABILITY | 9 |
|---|---|---|

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

| UNIT V | QUALITY AND RELIABILITY | 9 |
|---|---|---|

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development– Product life cycles.

| **Note:** Use of approved statistical table permitted in the examination. | **TOTAL PERIODS:** | 45 |
|---|---|---|

| **COURSE OUTCOMES**<br>At the end of the course, the students will be able to | | **BT MAPPED**<br>(Highest Level) |
|---|---|---|
| CO1 | summarize the concept of quality and process control for variables | Understanding (K2) |
| CO2 | apply the process control for attributes | Applying (K3) |
| CO3 | explain the concept of sampling and to solve problems | Understanding (K2) |
| CO4 | explain the concept of life testing | Understanding (K2) |
| CO5 | explain the concept Reliability and techniques involved | Understanding (K2) |

**TEXT BOOKS**

1. Douglas.C. Montgomery, "Introduction to Statistical quality control", 7th edition, John Wiley 2012.
2. Srinath. L.S., "Reliability Engineering", Affiliated East west press, Reprint,2018.

**REFERENCES**


1. Besterfield D.H., "Quality Control", Prentice Hall, 2013.
2. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2012
3. Danny Samson, "Manufacturing & Operations Strategy", Prentice Hall, 1991
4. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 2017


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | - | 2 | - | - | - | 1 | - | 1 | - | - | - | - |
| CO2 | 3 | 3 | - | 2 | - | - | - | 1 | - | 1 | - | - | 2 | 2 |
| CO3 | 3 | 3 | - | 2 | - | - | - | 1 | - | 1 | - | - | 2 | 2 |
| CO4 | 3 | 3 | 3 | 2 | - | - | - | 3 | - | 1 | - | - | 2 | 2 |
| CO5 | 3 | 3 | 3 | 2 | - | 3 | 2 | 2 | - | 1 | - | - | 1 | 1 |

| SF20503 | CHEMICAL TECHNOLOGY AND REACTION ENGINEERING | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | learn the manufacturing methods for various heavy chemicals and fertilizers and organic chemicals and to expose the students to the basics of reaction kinetics. |
| 2. | learn organic chemical elements like sugar, synthetic rubber, reactors and its behaviours etc.., |
| 3. | learn advance reaction technology and its function and application etc.., |
| 4. | concepts of catalysts, catalytic kinetic rate expressions, pore diffusion, and effectiveness factor |
| 5. | concepts of one-dimensional and two-dimensional pseudo homogeneous models. |

**UNIT I** **SIMPLE INORGANIC SUBSTANCES** **9**

Inorganic chemical technology - Chlor-alkali industries-soda ash-caustic soda-chlorine- hydrochloric acid. Manufacture of bricks-Steps only, Characteristics of good sand- Functions of sand, Chemical composition of cement, Method of manufacture of cement – Dry process(Flow chart only), Preparation of cement mortar, Plain concrete and reinforced concrete, Brick Masonry – Bonds in brick masonry.

**UNIT II** **SIMPLE ORGANIC SUBSTANCES** **9**

Organic chemical technology: Manufacturing processes for pulp and paper, sugar, industrial alcohol by fermentation-absolute alcohol, beers, wines, oils and fats, soaps and detergents, agrochemicals.

**UNIT III** **MECHANISM OF REACTION** **9**

Classification of reactions, variables affecting rate of reaction, definition of reaction rate. Kinetics of homogeneous reactions - concentration dependent term of a rate equation, temperature dependent term of a rate equation, theories of reaction - collision theory, transition theory, Arrhenius equation.

**UNIT IV** **PERFORMANCE OF REACTOR** **9**

Ideal reactors- Design for homogeneous systems, batch, stirred tank and tubular Flow reactor, design of reactors for multiple reactions, combination reactor system, and size comparison of reactors. Elementary ideas of non-ideal reactor performance, residence time distribution curves E, F and C...

**UNIT V** **SELECTION OF REACTORS** **9**

Size comparison of Single reactors, multiple reactor system, Reactions in Parallel and Series, Yield and Selectivity.

**TOTAL PERIODS:** **45**

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | analyse and improve the manufacturing methods for heavy chemicals and fertilizers | Analysing (K4) |
| CO2 | analyse and improve the manufacturing methods for organic chemicals and polymers. | Analysing (K4) |
| CO3 | analyse behaviours of reaction elements | Analysing (K4) |
| CO4 | analyse the batch reactor systems | Analysing (K4) |
| CO5 | perform design calculations of CSTR and PFR | Analysing (K4) |

**TEXT BOOKS**

1. Tapio Salmi and Jyri-pekka Mikkola,"Chemical Reaction Engineering and Technology",CRC press 2011 by Taylor & Francis Group, LLC, International Standard Book Number-13: 978-1- 4398-9485-9.
2. Davis, Mark E. and Davis, Robert J,".Fundamentals of chemical reaction engineering", McGraw- Hill, Chemical Engineering series. McGraw-Hill Higher Education , New York, NY. ISBN 007245007X,2018

**REFERENCES**

1. Fogler, H. S. (2016) Elements of Chemical Reaction Engineering, Pearson Education.
2. Levenspiel, O. (2010). Chemical reaction engineering. (third edition).Wiley India Pvt. Ltd., New Delhi.
3. Dr.Anil kumar Misra,"Building Materials and Construction",S.Chand Publication, 2017.
4. S.K.Duggal,"Building Materials",3rd Edition,New Age International (pvt) Limited Publishers,2019.

**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 1 | 1 | - | - | - | 1 | - | - | 2 | 2 | 3 |
| CO3 | 3 | 2 | 1 | 2 | 1 | - | - | - | 1 | 1 | - | 2 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | 1 | - | 2 | 2 | 3 |
| CO5 | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | 1 | 2 | 2 | 3 |

| SF20504 | DESIGN OF FIRE FIGHTING AND PROTECTION SYSTEM | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

1. know about the concepts functional design of building.
2. learn about thermal aspects and energy.
3. identify the tropical climates i.e. in Indian context and its need.
4. performing fenestration design for natural ventilation .
5. performing fenestration design for day lighting & design of space for external and internal noise control.

| UNIT I | INTRODUCTION | 9 |
|---|---|---|

Provisions & applicable standards of detection and alarm system, Introduction of detection devices, alarm and detection system, Type of detectors, Method of selection. Cost analysis, design, installation, testing and commissioning of alarm and detection system. Provisions& applicable standards of foam.

| UNIT II | HVAC SYSTEM | 9 |
|---|---|---|

Classification and property of foam, gases and dry chemical powder. Design Consideration. Basic psychometrics, Air conditioning process & system. Methods of Air Conditioning. Water Supply, Hydraulics.

| UNIT III | FIRE PROTECTION | 9 |
|---|---|---|

Identification, Hydraulic Calculation and Design of foam system: Installation identification, Hazard classification, Type of protection, Hazard description, Flammable or combustible liquids area to be protected, Flammable or combustible liquids identification, foam application method, Description, number and placement of foam application devices, Selection of foam agent, Rate of application of foam solution, Rate of foam concentrate, Rate of water application, Duration of discharge, Quantity of foam and water required.

| UNIT IV | PLANNED MAINTENANCE | 9 |
|---|---|---|

Planning vis-a-visadhoc maintenance, schedule & contingency maintenance, levels of planning, planned inspection, Maintenance cycle, maintenance profile, repair & replacement models, statistical methods, decision models, optimal renewal cycle, budgeting.

| UNIT V | DESIGN ON MAINTENANCE | 9 |
|---|---|---|

Effect of design on maintenance, Diagnosis, appraisal, structural defects & various methods of repair, Role of building maintenance in construction process Maintenance generators, Expression of Standards, selection of level of maintenance and fixing standards.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems. | Understanding (K2) |
| CO2 | specify designs that avoid occupation related injuries. | Remembering (K1) |
| CO3 | define and apply the principles of work design, motion economy, and work environment design. | Remembering (K1) |

| | | |
|---|---|---|
| CO4 | identify the basic human sensory, cognitive, and physical capabilities and limitations withrespect to human-machine system performance. | Applying (K3) |
| CO5 | acknowledge the impact of workplace design and environment on productivity. | Applying (K3) |

**TEXT BOOKS**

1. Industrial Fire Protection Engineering – Robert G.Zalosh, Wiley, Reprint,2018.
2. National Fire Protection Association Handbook

**REFERENCES**

1. Hydro Carbon Processing Unit Volume I,II
2. An Introduction to Fire Dynamics – Dougal Drysdale, ISBN: 978-0-470-31903-1, August 2011
3. Automatic Sprinkler performance table, Fire Journal, NFPA, Reprint,2017 Edition
4. Evaporation from plain liquid surface into a turbulent boundary layer – By BrightonP.W.N

**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | - | 2 | - | - | - | 1 | - | 1 | - | - | 2 | 1 |
| CO2 | 3 | 3 | - | 2 | - | - | - | 1 | - | 1 | - | - | 2 | 1 |
| CO3 | 3 | 3 | - | 2 | - | - | - | 1 | - | 1 | - | - | 2 | 1 |
| CO4 | 3 | 3 | 3 | 2 | - | - | - | 3 | - | 1 | - | - | 2 | 1 |
| CO5 | 3 | 3 | 3 | 2 | - | 3 | 2 | 2 | - | 1 | - | - | 2 | 1 |

| SF20505 | CHEMICAL PROCESS SAFETY | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | teach the principles of safety applicable to the design, and operation of chemical process plants. |
| 2. | identify and prevent the hazards and safe handling of material. |
| 3. | understand the risk analysis and its implementation. |
| 4. | learn the safety and hazard prevention. |
| 5. | have the knowledge of HAZOP. |

| UNIT I | SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES | 9 |
|---|---|---|

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories.

| UNIT II | CHEMICAL REACTION HAZARDS | 9 |
|---|---|---|

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,

| UNIT III | SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS | 9 |
|---|---|---|

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown – non-destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.

| UNIT IV | SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS | 9 |
|---|---|---|

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

| UNIT V | SAFETY AND ANALYSIS | 9 |
|---|---|---|

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS - Waste management.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES | BT MAPPED |
|---|---|
| At the end of the course, the students will be able to | (Highest Level) |

| | | |
|---|---|---|
| CO1 | differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants. | Understanding (K2) |
| CO2 | develop thorough knowledge about safety in the operation of chemical plants. | Applying (k3) |
| CO3 | apply the principles of safety in the storage and handling of gases | Applying (k3) |
| CO4 | define the potential hazards and recognizing unsafe conditions. | Remembering (K1) |
| CO5 | identify the conditions that lead to reaction hazards and adopt measures to prevent them. | Applying (K3) |

**TEXT BOOKS**

1. David A Crowl & Joseph F Louvar,"Chemical Process safety", Pearson publication, 3rd Edition,2014
2. Maurice Jones .A, "Fire Protection Systems,2nd edition, Jones & Bartlett Publishers,2015

**REFERENCES**

1. Ralph King and Ron Hirst,"King's safety in the process industries", Arnold, London, 2012.
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 2018.
3. National Safety Council," Accident prevention manual for industrial operations". Chicago, Reprint,2017.
4. Lewis, Richard. J., Sr,"Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, Reprint,2019.

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | - | 2 | 1 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | - | 1 | - | - | 2 | 2 | 3 |
| CO3 | 3 | 1 | 1 | 2 | 1 | 2 | 2 | - | 1 | 1 | 2 | 2 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | - | 2 | 2 | 3 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | - | - | - | 1 | 2 | 2 | 3 |

| SF20506 | HEAT AND MASS TRANSFER | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | learn the different modes of heat transfer and the concept of mass transfer operations employed in chemical industry. |
| 2. | impart the knowledge of mass transfer operations and equipment. |
| 3. | understand the fundamentals of heat transfer mechanisms in fluids and solids and their applications in various heat transfer equipment in process industries. |
| 4. | learn the thermal analysis and sizing of heat |
| 5. | understand the concepts of heat transfer through extended surfaces. |

| UNIT I | CONDUCTION | 10 |
|---|---|---|

General Differential equation of Heat Conduction- Cartesian and Polar Coordinates - One Dimensional Steady State Heat Conduction - plane and Composite Systems -Conduction with Internal Heat Generation -Extended Surfaces - Unsteady Heat Conduction - Lumped Analysis - Semi Infinite and Infinite Solids -Use of Heislers charts.

| UNIT II | CONVECTION | 8 |
|---|---|---|

Free and Forced Convection -Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

| UNIT III | PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS | 9 |
|---|---|---|

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types -Overall Heat Transfer Coefficient -Fouling Factors - Analysis - LMTD method -NTU method

| UNIT IV | RADIATION | 8 |
|---|---|---|

Black Body Radiation -Grey body radiation -Shape Factor -Electrical Analogy -Radiation Shields. Radiation through gases.

| UNIT V | MASS TRANSFER AND ABSORPTION | 10 |
|---|---|---|

Mass Transfer Fick's law, equimolar diffusion, diffusion of vapors through a stagnant medium ,applications Applications of mass transfer calculations to gas dissolution in molten metal's Absorption Equilibrium and operating line concept in absorption calculations ;types of contactors ,design of packed and plate type absorbers

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES | | BT MAPPED |
|---|---|---|
| At the end of the course, the students will be able to | | (Highest Level) |
| CO1 | identify the different modes of heat transfer and carry out the conduction calculations in various geometries. | Applying (K3) |
| CO2 | calculate the design requirements of heat transfer in co-current and counter-current heat exchanger operations. | Applying (K3) |
| CO3 | identify the best possible separation method with the given parameters | Applying (K3) |

| | | |
|---|---|---|
| CO4 | select the most suitable equipment for absorption, distillation, liquid-liquid extraction and solid-liquid extraction | Remembering (K1) |
| CO5 | develop an understanding of various Physico-chemical separation techniques | Applying (K3) |

**TEXT BOOKS**

1. Suryanarayana A.,"Mass Transfer Operations", New Age International,NewDelhi,2012.
2. Heat and Mass Transfer by Rudramoorthy and Mayilsamy, Pearson Education.

**REFERENCES**


1. Binay K.Dutta.(2011)Heat Transfer principles and applications, Prentice Hall of India,New delhi.
2. RobertE.Treybal.(2012).Mass transfer operations.(third edition).McGraw Hill Education, NewYork.
3. McCabe,W.L.,J.C.Smith,J.C.and Peter Harriott.(2014).Unit operations of chemical engineering (seventh edition). McGraw-Hill Education, NewYork.
4. Badger,W.L.and Banchero,J.T.(Reprint,20198).Introduction to chemical engineering.TataMc GrawHill Education, New Delhi.


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 1 | 3 | 2 | 2 | 3 | - | 3 | - | 3 | 2 | 2 | 3 | 3 |
| CO2 | 1 | 2 | 3 | 2 | - | 3 | - | - | 1 | 3 | 1 | - | 2 | 2 |
| CO3 | - | 2 | 3 | 1 | 2 | 3 | 2 | 1 | - | 3 | 2 | 2 | 3 | 2 |
| CO4 | - | - | 3 | - | - | 3 | - | - | 1 | 3 | 3 | - | 1 | 2 |
| CO5 | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 | - |

| SF20507 | MANUFACTURING TECHNOLOGY LABORATORY AND INTRODUCTION TO CAD | 0 | 0 | 2 | 1 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | select appropriate tools, equipment and machines to complete a given job. |
| 2. | learn essential concepts of moulding processes. |
| 3. | perform various machining processes such as turning, shaping, drilling, milling and grinding. |
| 4. | develop skill to use software to create 2d and 3d models. |

**LIST OF EXPERIMENTS**

1. Preparing green sand moulds with cast patterns.
2. Facing, Turning, step turning, taper turning using on circular parts using lathe machine.
3. Knurling, external and internal thread cutting on circular parts using lathe machine.
4. Drilling and reaming using vertical drilling machine.
5. Generating of Dove tail, Square and Hexagonal heads using Shaping machine
6. Generating of contour profile (Concave & Convex) using vertical milling machine
7. Generating spur gears using horizontal milling machine.
8. Cylindrical grinding and surface grinding operation.
9. Introduction to CAD
10. 2D and 3D figures for practice using AutoCAD 2013.

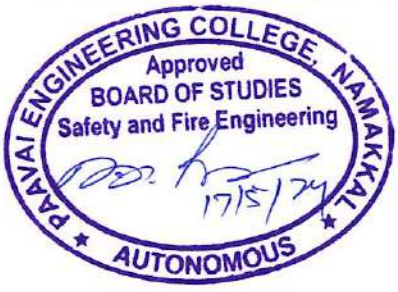
| | |
|---|---|
| **TOTAL PERIODS** | **30** |

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | prepare sand moulding using different patterns. | Applying (K3) |
| CO2 | apply operating practice to perform various lathe operations. | Applying (K3) |
| CO3 | perform various operations using drilling, shaping, milling and grinding machines. | Applying (K3) |
| CO4 | create 2d and 3d models of engineering components. | Remembering (K1) |

**CO – PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 1 | 1 | - | - | 1 | - | - | - | - | - | 2 | 2 | 2 |
| CO2 | 3 | 1 | 1 | - | - | 1 | - | - | - | - | - | 2 | 2 | 2 |
| CO3 | 3 | 1 | 1 | - | - | 1 | - | - | - | - | - | 2 | 2 | 2 |
| CO4 | 3 | 1 | 1 | - | 2 | 1 | - | - | - | - | - | 2 | 2 | 2 |



| SF20508 | UNIT OPERATIONS LABORATORY | 0 | 0 | 2 | 1 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | understand the practical aspects of the various unit operations employed in chemical industry. |
| 2. | acquire a sound working knowledge on different types of crushing equipment |
| 3. | characterized different mechanical operation separators based on the size and efficiency. |
| 4. | compare the efficiency of different types of distillation |

**LIST OF EXPERIMENTS**

1. Sieve Analysis - To analyse a given sample using a set of standard sieves and thus to determine the specific surface area, the volume surface mean diameter and the mass mean diameter by differential analysis and cumulative analysis.
2. Verification of the laws of crushing in a Ball mill and calculation of critical speed.
3. Study of the working of Plate and frame filter press.
4. Free settling - To find out the drag coefficient of a falling sphere in a Fluid and verification of Stoke's law.
5. Sedimentation - To study batch sedimentation of slurry and to determine the area of the continuous thickener.
6. Heat transfer from steam to air - Determination of overall heat transfer coefficient.
7. Verification of material balance equation and Rayleigh's equation for simple distillation.
8. Steam distillation.
9. Leaching - leaching a mixture of salt and sand.
10. Study of the kinetics of chemical reaction in a batch reactor.
11. Adsorption isotherms.
12. Frequency response of first and second order systems.

| | |
|---|---|
| **TOTAL PERIODS** | **30** |

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | determine the surface characteristics of solid particles | Remembering (K1) |
| CO2 | determine the energy requirements for size reduction equipment | Remembering (K1) |
| CO3 | calculate the area required for a continuous thickener | Applying (K3) |
| CO4 | compare the efficiency of different types of distillation | Analysing (K4) |

**CO – PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 2 | - | 3 | - | - | 1 | 2 | 3 | - | 2 | 2 | 3 |
| CO2 | - | - | - | - | - | - | 2 | - | 1 | - | - | - | 2 | 3 |
| CO3 | 2 | - | 2 | - | - | - | 1 | 2 | - | 2 | - | - | 3 | 2 |
| CO4 | - | 1 | - | - | - | - | 2 | - | - | - | - | 2 | 3 | 3 |

| EN20501 | CAREER DEVELOPMENT LABORATORY I | 0 | 0 | 2 | 1 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

1. enhance their writing skills.
2. evaluate their presentation skill to face the corporate world.
3. solve the quantitative aptitude problems and improve their mental ability.
4. improve the critical thinking and reasoning skills.

| UNIT I | WRITING SKILLS | 6 |
|---|---|---|

Writing Skills: The Essentials of Writing – The Importance of Structure – Types of Writing – Common Mistakes in Writing.

**Activities:** Email Writing - Paragraph writing – Report Writing – Story Writing - Story Telling Session: 2 – JAM Session 1.

| UNIT II | PRESENTATION SKILLS AND GROUP DISCUSSION | 6 |
|---|---|---|

Presentation Skills: Types of Presentation– Methods of Delivering Presentation –Ways to improve the Presentation – Presentation Aids: Group Discussion: Introduction –Types and Importance – Why GD – Types of GD- Evaluation Criteria – Do's and Don'ts of GD.

**Activities:** Presentation Session I, Group Discussion Session I, Role Play Session (Team): Level II – Personality Profile Session II – Company Profile Analysis Session II

| UNIT III | QUANTITATIVE APTITUDE | 6 |
|---|---|---|

Simplification – Cubes and Cube Roots – Squares and Square Roots – Boats and Streams – Trains – Profit and Loss – Pipes and Cisterns.

| UNIT IV | LOGICAL REASONING – I | 6 |
|---|---|---|

Series Completion – Letter Series – Symbol Series – Number Series – Arithmetic Reasoning.

| UNIT V | LOGICAL REASONING – II | 6 |
|---|---|---|

Blood Relations – Seating Arrangement - Character Puzzle.

| | TOTAL PERIODS: | 30 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | excel in drafting mails and speaking | Understanding (K2) |
| CO2 | demonstrate the participative skills in group discussions. | Understanding (K2) |
| CO3 | solve problems based on quantitative aptitude. | Applying (K3) |
| CO4 | enhance their logical and verbal reasoning. | Understanding (K2) |

**TEXT BOOKS**


1. Agarwal, R.S." a modern approach to Verbal and Non Verbal Reasoning", S.Chand and Co Ltd, new delhi.2015.
2. Agarwal, R.S. "Objective General English", S.Chand and Co.2016.

**REFERENCES**


1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.2015
2. Word Power Made Easy By Norman Lewis ,Wr.Goyal Publications.2016
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon. 2019
4. Infosys Campus Connect Program – students' guide for soft skills.2015


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 2 | 3 | 3 | 1 | - | - | - | - | - | - | 3 | 2 |
| CO2 | - | 2 | 3 | - | 2 | - | 2 | - | - | - | - | - | 3 | 2 |
| CO3 | 3 | 2 | 2 | - | - | 1 | - | - | - | - | 2 | - | 2 | 3 |
| CO4 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | - | 1 | 2 | - | 2 | 3 |

| SF20601 | LEGAL ASPECTS OF HEALTH SAFETY AND ENVIRONMENT | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | be aware of and to gain insight into the laws relating to industries, docks and harbors, labor welfare and environment protection. |
| 2. | an ability to select and apply the knowledge, techniques and modern tools of the discipline to fields broadly-defined as fire protection, health, environment and safety engineering and technology. |
| 3. | demonstrate a mastery of Health safety and environment knowledge and safety management skills, to reach higher levels in their profession. |
| 4. | effectively communicate on Health safety and environment, facilitating collaboration with experts across various disciplines so as to create and execute safe methodology in complex engineering environment. |
| 5. | provide a structured management approach to control safety risks in operations. |

| UNIT I | FACTORIES ACT | 9 |
|---|---|---|

Factories Act- Definitions, Preliminary, Inspecting staff, Health, Safety, Provisions relating to hazardous processes, Welfare, Working hours of adults, Employment of young persons, Special provisions. Dock Workers (Safety, Health and Welfare) Act - Definitions, Powers of inspectors, Power of Govt. to direct inquiry, Obligation of dock workers. Duties of Safety Officers, Reporting of accidents, Emergency Action Plan, Safety Committee.

| UNIT II | DOCK WORKERS (SAFETY, HEALTH AND WELFARE) ACT | 9 |
|---|---|---|

Employees' Compensation Act: Definitions, Employer's liability for compensation, Calculation of amount of compensation. ESI Act and Rules: Applicability, Definitions and Benefits. Public Liability Insurance Act and Rules- Definitions, Calculation of amount of relief, Environmental Relief Fund, Advisory Committee, Powers of District Collector, Extent of Liability, Contribution to Relief Fund.

| UNIT III | EXPLOSIVES ACT | 9 |
|---|---|---|

Explosives Act: Definitions, Categories of Explosives, General Safety Provisions, and Use of Explosives, Grant of license, Notice of Accidents, Inquiry into ordinary and more serious accidents, Extension of definition to other explosive substances. Explosives Rules, SMPV Rules and Gas Cylinder Rules (in brief). Petroleum Act with important rules - definitions, safety in the import, transport, storage, license, exemption, notice of accidents.

| UNIT IV | WORKMEN'S COMPENSATION ACT | 9 |
|---|---|---|

Water Act and Air Act: Definitions, powers and functions of Boards, prevention and control of pollution, consent administration. Environment (Protection) Act and Rules-Definitions, powers of central government, power of giving directions, authorities. MSIHC Rules- Definitions, Duties of Authorities, Notification of major accidents, safety Reports, safety audit, on- site & out-site emergency plans, safety information to public.

| UNIT V | POWER TO MAKE RULES | 9 |
|---|---|---|

Powers and Functions of Central, State and Joint Boards, Provisions regarding prevention and control of water pollution, Penalties, Central & State Water Laboratories, Power to make rules, Power of supersession and overriding effect. Rules on Consent for Establishment

| Note: Case laws may be referred if necessary, but those are beyond the scope of this course. | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>Upon the completion of this course the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | gain knowledge and to apply the knowledge on provisions relating to Hazardous process. | Applying (K3) |
| CO2 | gain knowledge on laws relevant and concerning towards welfare, working hours and health and safety of workers engaged in industries. | Understanding (K2) |
| CO3 | learn various laws relevant for inquiry into certain accidents, Advisory Committee, Inquiry in Public, and Reporting of accidents, Emergency Action Plan, Safety Committee, Occupational Health services for dockworkers, various safety and health regulations in brief. | Understanding (K2) |
| CO4 | understand and learn about the legal aspects granting of license for storage, transportation and usage of explosive substance as applicable as per Petroleum Act and Explosive Act. | Understanding (K2) |
| C05 | understand the legal obligations regarding any injury by gaining knowledge of Workmen's Compensation Act. ESI Act & Rules. Public Liability Act & Rules. | Understanding (K2) |

**TEXT BOOKS**

1. K.T.Narayanan, "Safety, Health and Environment Handbook Hardcover",1st Edition,McGraw Hill Education (India) private limited,2017
2. Gayle wood side and Dianna Koeurek, "Environmental Safety and Health Engineering", John Wiley & Sons, Reprint, 2018.

**REFERENCES**

1. Environmental Management Handbook for Hydrocarbon Processing Indus; James B. WellFactories Act, Reprint,2018.
2. Ganguly & Changeriya,"Health Safety and Environment
3. Explosives Act and related Rules & The Gas Cylinder Rules, 2014, Professional Book publishers
4. Petroleum Act and Rules & The Petroleum Act, 1934 © Universal Law publishing

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | - | 1 | - | - | 1 | 1 | - | - | - | - | - | 1 | 2 |
| CO2 | - | 1 | - | - | 1 | 2 | - | - | - | 1 | - | - | 3 | 2 |
| CO3 | 2 | - | - | - | - | 1 | - | 1 | 1 | - | - | - | 2 | 2 |
| CO4 | 2 | 1 | 2 | - | 1 | 1 | - | - | - | - | - | - | 2 | 2 |
| CO5 | 1 | - | 2 | 3 | - | - | - | - | - | - | - | 1 | 2 | 2 |

| EE20607 | PROCESS CONTROL AND INSTRUMENTATION | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1 | introduce the various processes control and modelling of physical processes. |
| 2 | get adequate knowledge about basic control actions and controller tuning. |
| 3 | understand the instrumentation parameters for thermal power plant. |
| 4 | know the process instrumentation for nuclear power plant. |
| 5 | familiarize about the safety system and related issues. |

**UNIT I PROCESS CONTROL** **9**

Need for process control – Hierarchical decomposition of control functions; Servo and regulatory operations; Continuous and Batch processes; Mathematical Modeling of Processes- Level, flow and thermal processes, lumped and distributed parameter models; Degrees of freedom; Interacting and non-interacting systems; Self-regulation; Linearization of non-linear systems.

**UNIT II CONTROL ACTIONS** **9**

Basic control actions – Characteristics of ON/OFF, P, P+I, P+D, P+I+D control modes; Practical forms of PID Controller; PID Implementation; Issues - Bumpless auto/manual mode transfer, anti-reset windup techniques and direct/reverse action; Ziegler-Nichols controller tuning.

**UNIT III INSTRUMENTATION FOR THERMAL POWER PLANT** **9**

Measurement of feed water flow, air flow, steam flow and coal flow; Drum level measurement; Steam pressure and temperature measurement; Turbine speed and vibration measurement; Flue gas analyzer; Fuel composition analyzer.

**UNIT IV INSTRUMENTATION FOR NUCLEAR POWER PLANT** **9**

Nuclear radiation sensors- Out of core neutron sensors, in core; Process instrumentation - temperature sensing, pressure sensing and transmitting, flow sensing, level and position sensing, steam properties sensing, water properties sensing, gas properties sensing; Special sensor for sodium cooled reactors and gas cooled reactors.

**UNIT V SAFETY IN INSTRUMENTATION SYSTEMS** **9**

Hazardous zone classification – Electrical and intrinsic safety; Explosion suppression and Deluge systems; Flame, fire, smoke detectors, leak detectors; General SIS design configurations; Hazard and risk assessment; Failure modes – Operation and maintenance.

**TOTAL PERIODS** **45**

**COURSE OUTCOMES**

| At the end of this course, students will be able to | | **BT Mapped (Highest Level)** |
|---|---|---|
| **CO1** | describe the basic principles and modelling of process control in industrial process plants. | Understanding (K2) |
| **CO2** | explain the control actions and methods of controller tuning. | Understanding (K2) |

| | | |
|---|---|---|
| **CO3** | interpret the instrumentations for thermal power plant. | Understanding (K2) |
| **CO4** | infer the instrumentation requirements for nuclear power plant. | Understanding (K2) |
| **CO5** | examine about a safety system and hazards. | Understanding (K2) |

**TEXT BOOKS**

1. Raghunathan Rengaswamy, Babji Srinivasan, Nirav Pravinbhai Bhatt "Process Control Fundamentals: Analysis, Design, Assessment, and Diagnosis", First Edition, 2020.
2. D.Patranabis, "Principles of Industrial Instrumentation", Third Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, Reprint 2019.

**REFERENCES**


1. D. Patranabis, "Principles of Process Control", Tata McGraw Hill, Third Edition, Reprint 2018.
2. Gill, A.B., "Power Plant performance", Elsevier 2016.
3. Paul Gruhn and Harry Cheddie, "Safety Instrumented Systems: Design, Analysis, and Justification", Second Edition, ISA Press, 2016.
4. B.G.Liptak, "Instrumentation Engineers Handbook (Measurement)", Fourth Edition, Volume 1, CRC press, Reprint 2019.


**CO-PO MAPPING:**

**Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's**
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak**

| | Programme Outcomes PO's | | | | | | | | | | | | PSO's | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO's** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** |
| **CO1** | 3 | - | - | - | - | - | - | - | - | - | - | - | 3 | 1 |
| **CO2** | 3 | 3 | - | - | - | 1 | - | 2 | 2 | - | - | 2 | 3 | 1 |
| **CO3** | 3 | 2 | - | - | - | 1 | - | - | 3 | 2 | - | 2 | 3 | - |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | 3 | - |
| **CO5** | - | - | - | 3 | 3 | 3 | - | - | - | - | - | - | 3 | - |

| SF20602 | HAZARD CONTROL IN MANUFACTURING INDUSTRY | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | learn about the various hazards associated with the manufacturing processes employed in engineering industries and methods used to safeguard the operators and others. |
| 2. | understand the concepts of global scenario of Health & safety. |
| 3. | analyses the gaps between reference standards & pertinent conditions of safety in India. |
| 4. | students should be able to analyses and solve basic agronomical issues. |
| 5. | efficient in the operation of industrial hygiene equipment. |

| UNIT I | INTRODUCTION TO MANUFACTURING PROCESSES | 9 |
|---|---|---|

Introduction - Classification of Engineering Industry - Manufacturing Processes Hot Working - Foundry operations-furnace and equipment, health hazard, safe methods of operation. Forging operations, heat radiation, maintenance of machines, shop equipment and hand tools - safe work practice. Operations i hot and cold rolling mills.

| UNIT II | HAZARDS SAFETY MEASURES IN MANUFACTURING INDUSTRY | 9 |
|---|---|---|

Machinery safeguard-Point-of-Operation, Principle of machine guarding - breakdown of machine guarding – types of guards and devices. Cold Working-Safety in Power Presses, primary & secondary operations – shearing -bending - rolling - drawing. Metal Cutting- safety in turning, boring, milling, planning and grinding. Maintenance of machine tools - health hazards and prevention.

| UNIT III | CONCEPTS OF FIRE SAFETY IN INSTALLATIONS | 9 |
|---|---|---|

Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Cutting and Finishing. Gas Cylinders and Equipment's. Heat Treatment- Furnaces and Salt baths-operations and maintenance -safety in handling and storage of salts - health precautions, exposure to hazardous fumes, source of fumes.

| UNIT IV | FUNDAMENTALS OF MATERIAL HANDLING | 9 |
|---|---|---|

Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of Common elements- wire rope, chains slings, hooks, clamps.

| UNIT V | SAFETY IN OIL AND GAS PLANT | 9 |
|---|---|---|

Well Completion Practices: Well- Head Assemble, Installation and Testing, Activation, Well Testing, Self-Flowing Wells, Gas Lift: Sucker Rod and Down Hole Motor Pumping of Oil, Safety Issues in Oil and Gas Production.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | explain the various hazards associated with hot working of metals and methods of control | Understanding (K1) |
| CO2 | know about various hazards associated with cold working and cutting of metals and methods of control | Understanding (K1) |

| | | |
|---|---|---|
| CO3 | relate various hazards associated with welding and cutting of metals and methods of control | Understanding (K1) |
| CO4 | analyse various material handling methods and systems; the hazards and methods of control | Analysing (K4) |
| C05 | build the stability of a control system in A to Z of Environmental Audit. | Applying (K3) |

**TEXT BOOKS**

1. SC Bhatia, "A Handbook on health, Safety and Environment", 2017
2. James T. Tweedy, "Introduction to Hazard Control Management, CRC Press,2013

**REFERENCES**


1. National Safety Council. "Accident prevention manual for industrial operations". Chicago,Reprint 2017.
2. Ronald P. Blake. "Industrial safety". Prentice Hall, New Delhi. Balchin, N.C.,2005. Health and Safety in Welding and Allied process, Jaico Publishers, New Delhi, 2018.
3. E-Waste Managing the Digital Dump Yard, Edited by VishakhaMunshi, ICFAI University Press
4. J.M. Goel," Hazardous Waste Management" Perspectives in Nuclear Toxic and Hazardous Waste by Kadambari Sharma.


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | - | 2 | - | 2 | 1 | - | - | - | - | - | - | 2 | 1 |
| CO2 | - | - | 3 | - | - | - | 1 | - | - | - | - | 1 | 2 | 1 |
| CO3 | 1 | 2 | - | - | - | - | - | - | 1 | - | - | - | 2 | 1 |
| CO4 | 2 | - | - | - | - | - | 2 | - | - | - | - | - | 2 | 1 |
| CO5 | 3 | - | - | - | - | - | - | 1 | - | - | - | 1 | 2 | 1 |

| SF20603 | ENVIRONMENTAL ENGINEERING LABORATORY | 0 | 0 | 2 | 1 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | impart the principles of sampling and preservation of water and wastewater |
| 2. | acquire the knowledge on the principles of testing of water and wastewater. |
| 3. | learn different analysis methods for water and waste water. |
| 4. | acquire knowledge about importance of oxygen in wastewater. |

**LIST OF EXPERIMENTS**

1. Determination of pH and turbidity in water.
2. Determination of Hardness in water.
3. Determination of Optimum coagulant dosage in water.
4. Determination of Chlorides in water.
5. Determination of fluoride in water by spectrophotometric method
6. Determination of and residual chlorine in water
7. Determination of Total, suspended and dissolved solids in waste water.
8. Determination of sludge volume index in waste water
9. Determination of Dissolved Oxygen and BOD for the given sample.
10. Determination of COD for given sample.

| | |
|---|---|
| **TOTAL PERIODS** | **30** |

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | determine the pH and turbidity of water and waste water. | Applying (K3) |
| CO2 | analyze the characteristics of water and waste water as per standards. | Analysing (K4) |
| CO3 | examine different analysis methods of water and waste water. | Analysing (K4) |
| CO4 | know about importance oxygen in waste water. | Analysing (K4) |

**CO – PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 2 | - | 3 | - | - | 1 | 2 | 3 | - | 2 | 2 | 3 |
| CO2 | - | - | - | - | - | - | 2 | - | 1 | - | - | - | 2 | 3 |
| CO3 | 2 | - | 2 | - | - | 2 | 1 | 2 | - | 2 | - | - | 3 | 2 |
| CO4 | - | 1 | - | - | - | - | 2 | - | - | - | - | 2 | 3 | 3 |

| SF20604 | DESIGN AND FABRICATION PROJECT | 0 | 0 | 4 | 2 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | get hands on training in the fabrication of one or more components and assemble a complete working model with appropriate design |
| 2. | revise the fundamental knowledge acquired during earlier semesters and apply in real time problems |
| 3. | form a team and execute a simple project in relevant area of safety and fire engineering by applying knowledge of design process, material selection and fabrication techniques |
| 4. | learn application software to model and analyze machine parts that would reduce cost, time and also improve the quality of the project. |

**GUIDELINES FOR REVIEW AND EVALUATION**

1. A Team is formed with minimum of 2 to 4 students and they have to work under a project supervisor.
2. The components to be fabricated may be decided in consultation with the supervisor and if possible with an industry.
3. A project report to be submitted by the group and the fabricated model will be reviewed and evaluated for internal assessment by a committee constituted by the Head of the Department.
4. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

| | |
|---|---|
| **TOTAL PERIODS** | **60** |

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | learn the uses of design principles and develop conceptual components related to safety and fire engineering. | Understanding (K2) |
| CO2 | demonstrate the working model of the machine elements in accordance with the safety elements as studied in previous semesters. | Understanding (K2) |
| CO3 | apply modelling and analyzing software for modelling and analyzing real time components in a part or assembly and study their Static and dynamic characteristics. | Applying (K3) |
| CO4 | design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, safety, global impact, manufacturability and sustainability aspects. | Applying (K3) |

**CO – PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 1 | 1 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 1 | 3 | 2 | - | 1 | - | 3 | - | 1 | 3 | 3 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 3 | 3 |
| CO4 | 3 | - | 3 | - | - | [illegible] | [illegible] | [illegible] | - | - | - | 3 | 2 | 3 |

| EN20601 | CAREER DEVELOPMENT LABORATORY II | 0 | 0 | 2 | 1 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | draft resume and enhance their skills to manage stress to survive in corporate world. |
| 2. | excel in interview skills. |
| 3. | solve the quantitative aptitude problems and improve their problem-solving skills. |
| 4. | improve their reasoning skills to get placed in reputed companies. |

| UNIT I | RESUME WRITINGS | 6 |
|---|---|---|

Resume Writing Skills: Curriculum Vitae and Resume – Things to do while writing a Resume – Mistakes and Pitfalls to Avoid- Cover Letter: General Guidelines – The Content - Stress Management – Dressing Etiquette

**Activities:** Corporate Resume Building Session I – JAM Session: Level III – Role Play Session (Individual): Level III - Company Profile Analysis Session III – Personality Profile Analysis Session III

| UNIT II | INTERVIEW SKILLS | 6 |
|---|---|---|

Interview Skills: Introduction – Before the Interview – During the Interview – After the Interview – Types of Interview.

**Activities:** Presentation Session: Level II- Group Discussion Session: Level III ,Mock Interview Practice Session, Corporate Resume Building Session II

| UNIT III | QUANTITATIVE APTITUDE | 6 |
|---|---|---|

Permutation and Combination – Probability: Dice, Colours, Coin, Cards ; Partnership – Ages – Calendars

| UNIT IV | LOGICAL REASONING – I | 6 |
|---|---|---|

Making Judgements – Matching Definitions – Cause and Effect

| UNIT V | LOGICAL REASONING – II | 6 |
|---|---|---|

Directions – Syllogism – Analogy – Statements and Arguments

| | TOTAL PERIODS: | 30 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | write resume and enhance their etiquettes. | Understanding (K2) |
| CO2 | demonstrate the interpersonal skills in group discussions. | Applying (K3) |
| CO3 | compute problems based on quantitative aptitude. | Applying (K3) |
| CO4 | reveal their logical and verbal reasoning by scoring the expected percentage to get placed in reputed companies. | Understanding (K2) |

**TEXT BOOKS**


1. Agarwal, R.S." a modern approach to Verbal and Non Verbal Reasoning", S.Chand and Co Ltd, new delhi.2015.
2. Agarwal, R.S. "Objective General English", S.Chand and Co.2016.


**REFERENCES**


1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.2015

2. Word Power Made Easy By Norman Lewis ,Wr.Goyal Publications.2016

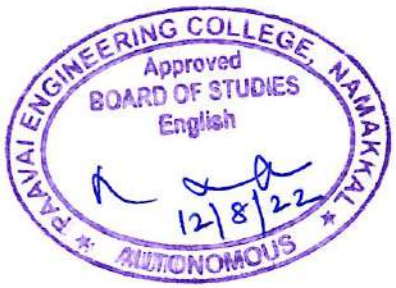
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon. 2019

4. Infosys Campus Connect Program – students' guide for soft skills.2015

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 2 | 3 | 3 | 1 | - | - | - | - | - | - | 3 | 2 |
| CO2 | - | 2 | 3 | - | 2 | - | 2 | - | - | - | - | - | 3 | 2 |
| CO3 | 3 | 2 | 2 | - | - | 1 | - | - | - | - | 2 | - | 2 | 3 |
| CO4 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | - | 1 | 2 | - | 2 | 3 |



| SF20151 | INDUSTRIAL ENGINEERING | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | establishing methods for improving operations and controlling production costs. |
| 2. | developing ways of reducing costs. Researching ways of improving efficiency of processes |
| 3. | improving production processes and simultaneously ensuring worker safety |
| 4. | has the ability to use modern engineering tools, software and equipment to analyze problems. |
| 5. | will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues |

| UNIT I | INTRODUCTION | 9 |
|---|---|---|

Definition of Industrial Engineering: Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement – various methods, time study PMTS, determining time, Work sampling, Numericals. Productivity & Workforce Management: Productivity - Definition, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity.

| UNIT II | MANUFACTURING COST ANALYSIS | 9 |
|---|---|---|

Manufacturing Cost Analysis: Fixed & variable costs, Direct, indirect & overhead costs, & Job costing, Recovery of overheads, Standard costing, Cost control, Cost variance Analysis - Labour, material, overhead in volume, rate & efficiency, Break even Analysis, Marginal costing & contribution, Numericals. Materials Management : Strategic importance of materials in manufacturing industries, Relevant costs, Inventory control models - P,Q,Ss Systems, Service level, Stock out risk, determination of order point & safety stock, Selective inventory control - ABC, FSN, SDE, VED and three dimensional, Numericals.

| UNIT III | QUALITY MANAGEMENT | 9 |
|---|---|---|

Quality Management: Definition of quality, Various approaches, Concept of quality assurance systems, Costs of quality, Statistical quality Control (SQC), Variables & Attributes, X, R, P & C - charts, Acceptance sampling, OC - curve, Concept of AOQL, Sampling plan - Single, Double & sequential, Introduction to TQM & ISO - 9000. Production Planning & Control (PPC) : Introduction to Forecasting - Simple & Weighted moving average methods, Objectives & variables of PPC, Aggregate planning - Basic Concept, its relations with other decision areas, Decision options – Basic & mixed strategies, Gantt chart, Introduction to JIT.

| UNIT IV | MANAGEMENT INFORMATION SYSTEMS | 9 |
|---|---|---|

Management Information Systems (MIS) : What is MIS ? Importance of MIS, Organizational & information system structure, Role of MIS in decision making, Data flow diagram, Introduction to systems analysis & design, Organizing information systems. Product Design and Development: Various Approaches, Role 3S's – Standardization, Simplification, Specialization, Introduction to value engineering and analysis, Role of Ergonomics in Product Design.

| UNIT V | PRODUCTION SCHEDULING | 9 |
|---|---|---|

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban –

Dispatching-Progress reporting and expediting Manufacturing lead time-Techniques for aligning completion times and due dates.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES | | BT MAPPED |
|---|---|---|
| At the end of the course, the students will be able to | | (Highest Level) |
| CO1 | make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques. | Applying (K3) |
| CO2 | understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances. | Understanding (K2) |
| CO3 | the student will be able to identify/control the appropriate process parameters, and possible defects of manufacturing processes so as to remove them. | Applying (K3) |
| CO4 | the student will be able to develop simplified manufacturing processes with the aim of reduction of cost and manpower | Applying (K3) |
| C05 | an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. | Applying (K3) |

**TEXT BOOKS**

1. Modern Production Management – S.S. Buffa, Pub. - John Wiley.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand

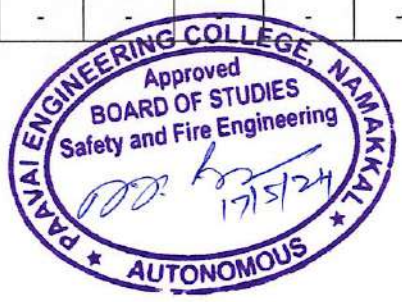
**REFERENCES**


1. Jain. K.C. &Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 2018.
2. Industrial and Systems Engineering - Turner, MIZE, CHASE, Prentice Hall Pub.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 2017.


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | - | 1 | - | - | 1 | 1 | - | - | - | - | - | 1 | 2 |
| CO2 | - | 1 | - | - | 1 | 2 | - | - | - | 1 | - | - | 3 | 1 |
| CO3 | 2 | - | - | - | - | 1 | - | 1 | 1 | - | - | - | 2 | 1 |
| CO4 | 2 | 1 | 2 | - | 1 | 1 | - | - | - | - | - | - | 1 | 1 |
| CO5 | 1 | - | 2 | - | - | - | - | - | - | - | - | 1 | 1 | 2 |



| SF20152 | SAFETY MANAGEMENT | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | demonstrate the approaches and techniques to assess and improve process and/or product quality and reliability. |
| 2. | introduce the new safety process, principles and technical leadership. |
| 3. | iillustrate the basic concepts and techniques of modern safety engineering tools. |
| 4. | understand process control and safety procedure and their application. |
| 5. | learn the concept of accident management. |

| UNIT I | INTRODUCTION | 9 |
|---|---|---|

Hinrichs Axioms of Industrial Safety, Concepts of Safety, Organization for Safety, Organization, Definition, Need & Principles Organizing for Health and Environmental, Activities, Organization Structure, Function & Responsibilities.

| UNIT II | SAFETY MANAGEMENT PROCESS | 9 |
|---|---|---|

Directing for Safety, Direction, Definition, Process, Principles and Techniques Leadership, Role, Function and, Attributes of a Leader.

| UNIT III | SAFETY POLICY | 9 |
|---|---|---|

Safety Management System, Objectives of Health, Safety and Environment Policy, Responsibility for Implementation of HSE Policy.

| UNIT IV | STRUCTURE AND FUNCTIONS OF SAFETY COMMITTEE | 9 |
|---|---|---|

Role of Occupier and Factory Manager, Factory Safety Committee, Structure and Functions and Working Tenure Details.

| UNIT V | ACCIDENT MANAGEMENT | 9 |
|---|---|---|

Accident Prevention: Definition: Incident, Accident, Injury, Dangerous occurrence, Unsafe Act, Unsafe Conditions, Hazards, Error, Oversight, Mistake, Nearmiss, Electricity & Hazards of Electricity, Explosives and Transportation Safety.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | attain the basic concepts of safety, fundamental knowledge of principles organizing for health and environmental. | Applying (K3) |
| CO2 | use control charts to analyze for improving the process safety. | Analysing (K4) |
| CO3 | describe different safety management. | Understanding (K2) |
| CO4 | acquire basic knowledge of functional safety management | Applying (K3) |
| C05 | understand the concepts of accident prevention. | Understanding (K2) |

**TEXT BOOKS**


1. R.K.Mishra, "Safety Management", AITBS Publishers, 2nd edition, 2012.
2. Universal Law Publishing, "The Factories Act 1948" Universal Law Publishing, 2018.

**REFERENCES**


1. K.U. Mistry, "Fundamentals of Industrial safety & health", Shyamaraj Global Commerce, 2022.
2. Sunil S. Rao, R.K. Jain and H.L. Saluja, "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 2nd edition 1997.
3. R.K. Jain and Prof. Sunil S. Rao, "Industrial Safety, Health and Environment Management Systems", Khanna Publishers, 2000.
4. Heinrich H. W., "Industrial Accident Prevention" McGraw-Hill Company, New York, 5th Edition 2007.


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | - | - | - | 1 | - | - | 1 | - | - | - | 2 | 2 | 1 |
| CO2 | - | 1 | - | - | - | 1 | - | - | 1 | - | - | - | 2 | 2 |
| CO3 | 1 | - | - | 2 | 1 | - | 2 | 1 | - | - | - | - | 2 | 3 |
| CO4 | - | 1 | - | 2 | - | - | - | - | - | - | - | - | 3 | 1 |
| CO5 | 1 | - | 1 | - | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 1 |

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AUTONOMOUS

| SF20153 | HAZARD ANALYSIS AND RISK ASSESSMENT | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | learn the various techniques for hazard identification, reliability analysis, estimation of frequency of occurrence of hazards, consequence analysis, risk quantification and human reliability analysis. |
| 2. | provide knowledge in Quantitative Risk Analysis Process Industries |
| 3. | provide in-depth knowledge of risk Control and Management |
| 4. | familiarize the student with various types of Hazard Identification techniques |
| 5. | dentify various Hazards related to the work practices and activity using various technique. |

**UNIT I** **HAZARD IDENTIFICATION AND RISK ANALYSIS** **9**

Hazard and risk, Types of hazards -fire, explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Preliminary hazard analysis, Hazard and Operability study (HAZOP), Case studies.

**UNIT II** **RISK CONTROL & MANAGEMENT** **9**

Plant availability and process reliability: ways of improving plant availability, MTBF and MTTF, the reliability function, failure rate, bathtub curve, probability relationships, simple reliability estimation. The logic tree approach, set theory and Boolean algebra, application to probability, Boolean manipulation. Event tree analysis –notation. Failure mode and Effect Analysis (FMEA) -methodology, criticality analysis, corrective action and follow-up.

**UNIT III** **ENVIRONMENTAL HEALTH RISKS** **9**

Consequence modelling: Source models -discharge rate models, flash and evaporation, dispersion models. Explosions and fires -vapour cloud explosions, flash fires, physical explosions, BLEVE and fireball, confined explosions, pool fires, jet fires. Effect models -dose-response functions, profit functions, toxic gas effects, thermal effects, explosion effects.

**UNIT IV** **HAZARDS MONITORING AND EMERGENCY MANAGEMENT** **9**

Quantification of risk: QRA, Vulnerability analysis, accepted and imposed risk, perception of risk, risk indices, individual risk and societal risk, acceptance criteria for risk, ALARP, Presentation of measures of risk –risk contour, F-N curve. Calculation of individual risk and societal risk. Human reliability analysis (HRA) factors leading to human error, characteristics of HRA techniques, Technique for Human Error Rate Prediction (THERP), Accident Sequence Evaluation Program (ASEP).

**UNIT V** **DISASTER MANAGEMENT IN INDIA AND RELIEF** **9**

History of disasters -various disasters in various countries -Disasters in India Relief and rehabilitation in disasters at local, national and global levels, Gaps in disaster management identified on analysis Worldwide Aid and Agencies, Study of different case studies on natural disaster & manmade disaster

**TOTAL PERIODS:** **45**

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | attain the ability to use the hazard indices, HAZOP, PHA and What if analysis for the identification of hazards in a process | Applying (K3) |

| | | |
|---|---|---|
| CO2 | attain the ability to assess probability of occurrence of an event using fault tree and event tree analysis | Applying (K3) |
| CO3 | estimate the consequences of fire, explosion and toxic gas release using suitable empirical models | Understanding (K2) |
| CO4 | quantify the risk involved in a process | Analysing (K4) |
| C05 | identify various Hazards related to the work practices and activity using various technique. | Understanding (K2) |

**TEXT BOOKS**

1. Geoff Wells, "Hazard Identification and Risk Assessment", 2017.
2. Marvin Rausand ,"Risk Assessment", John Wiley & Sons, Inc,2011

**REFERENCES**


1. AIChE/CCPS."Guidelines for Hazard Evaluation Procedures". (Second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 1992.
2. AIChE/CCPS."Guidelines for Chemical Process Quantitative Risk Analysis". (Second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 2000.
3. Sam Mannan (Editor)."Lee´s Loss Prevention in the Process Industries". (Fourth edition), Butterworth-Heinemann Ltd., UK, 2012.
4. Government of India, Ministry of Home Affairs, National Disaster Management Division, Disaster Management in India –A Status Report,2004


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 2 | - | 2 | - | - | - | - | - | 2 | - | 2 | 2 |
| CO2 | - | 2 | 2 | - | - | - | - | - | 2 | 2 | 1 | - | 3 | 2 |
| CO3 | 3 | 1- | - | - | - | - | - | - | - | - | - | - | 1 | 3 |
| CO4 | - | - | - | - | - | 2 | - | - | - | - | - | 1 | 2 | 2 |
| CO5 | 1 | - | - | - | - | 2 | - | 1 | - | - | - | - | 3 | 3 |

| SF20154 | FIRE SAFETY CODES AND STANDARDIZATION | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1 | acquire knowledge of Fire and Safety Studies |
| 2 | learn about the emergency tender and its codes |
| 3 | learn about fire area, fire stopped areas and different types of fire extinguishers |
| 4 | know about the method of fire protection of structural members and their repair due to fire damage. |
| 5 | develop safety professionals for both technical and management through various building codes |

| UNIT I | SPECIFICATION OF RESCUE AND FIRE | 9 |
|---|---|---|

Fighting equipment and appliances viz., TP, Water Tender C. F. T. and I.S.Standard ( IS 948, IS 950 IS 6067, IS 10460 ,IS 4989 (PART-1) IS -4989(PART-3),IS -949,IS 951,IS 944 , IS 2930,IS-947 IS 6070, IS 957 ,IS-946 ,942 , IS-8090, IS-2190 ,IS-903 IS-636.

| UNIT II | SALVAGE TENDER | 9 |
|---|---|---|

Salvage Tender Emergency Tender, Rescue tender, DCP Tender IS-10993, IS-949Fire Science- Basic Principles Basic Principles of Combustion Process

| UNIT III | FIRE EXTINCTION/SUPPRESSION TECHNOLOGY | 9 |
|---|---|---|

Fire Extinction/Suppression Technology, Constituents of Fire Methods of Fire Extinguishment Extinguishing Media, Fixed Fire Extinguishing Systems, First-aid Fire Fighting Equipment Code concerning construction and design of buildings. NBC -1983

| UNIT IV | CODE OF PRACTICE FOR CONSTRUCTION | 9 |
|---|---|---|

Code of practice for construction of temporary structures and pandals IS -8758 Codes relating to fire ratings of materials used.

| UNIT V | LAWS IN FIRE PREVENTION | 9 |
|---|---|---|

Municipal Bye- Laws in relating to fire prevention, industrial fire Prevention and Protection enforcement. Fire Protection/Fire Safety Management for various classes of Occupancies Building Codes and Regulations

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | understand the effect of fire on materials used for construction. | Understanding (K2) |
| CO2 | understand the method of test for non-combustibility and fire resistance | Understanding (K2) |
| CO3 | understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread. | Understanding (K2) |
| CO4 | decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire. | Applying (K3) |
| C05 | describe the safety techniques and improve the analytical and intelligence to take the right decision at right time. | Understanding (K2) |

**TEXT BOOKS**

1. Hand book on Building Fire Codes by G.B. Menon IIT Kanpur
2. Fire Safety In Building by V K Jain 3rd edition New Age International Publishers

**REFERENCES**

1. Principles Of Fire Safety Engineering by Das Akhil Kumar PHI Learning Pvt Ltd
2. A Handbook On Industrial Safety and Fire Management by Ravi Kant Pandey,1st edition Chetan prakashan publication
3. International code of fire safety systems by International Maritime Organization ,International Maritime Organization publications 2017 edition.
4. Industrial Safety, Health And Environment Management Systems Paperback – 1 January 2018 by R. K. Jain (Author), Sunil S. Rao (Author).2018

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 1 | - | 1 | - | - | - | - | 1 | - | - | 1 | - | 2 | 1 |
| CO2 | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 | 2 |
| CO3 | 2 | - | 1 | - | - | - | - | - | - | - | 2 | - | 2 | 3 |
| CO4 | 1 | - | 2 | - | - | - | - | 1 | - | - | - | - | 3 | 1 |
| CO5 | 1 | - | - | - | - | - | - | 1 | - | - | - | 2 | 2 | 1 |

| SF20251 | FIRE ENGINEERING | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | understand the basic theory of fire chemistry, the development of fire and its characteristics, and about different types of fire. |
| 2. | study about the product of combustion and their characteristics. |
| 3. | study about the use, operation and maintenance requirements of equipment, vehicles and accessories used in fire services. |
| 4. | understand the fundamentals of fire hydraulics and fire ground operations. |
| 5. | focuses on fire detection, suppression and mitigation and fire safety engineering which focuses on human behaviour and maintaining a tenable environment for evacuation from a fire. |

| UNIT I | PROPERTIES OF COMBUSTION | 9 |
|---|---|---|

Introduction- temperature, heat, specific heat, flash point, fire point, ignition, combustion; Ignition- pilot ignition, spontaneous ignition, ignition sources; Types of combustion-rapid, spontaneous, explosion;. Development of fire- incipient, smouldering, flame and heat stages; Diffusion flames-zones of combustion, smouldering combustion, characteristics of diffusion flame; Special kinds of combustion- Flash fire, Pool fire, Deep seated fire, Spill over, Boil over, Dust explosion, BLEVE, UVCE; Classification of fire based on material.

| UNIT II | COMBUSTION FLAME | 9 |
|---|---|---|

Product of combustion-flame, heat, smoke, fire gases; Flame and its characteristics, spread of flames in solids and liquids, linear and three dimensional fire propagation; spread of fire in rooms and buildings; Effect of heat exposure to human body, body burns. Smoke - constituents of smoke, quantity and rate of production of smoke, quality of smoke, smoke density, visibility in smoke, smoke movement in buildings, modelling of smoke movement; Smoke control in buildings- natural and mechanical ventilation, pressurization; Design principles of smoke control using pressurization technique; Principles of smoke vent design.

| UNIT III | FIRE SERVICE EQUIPMENTS AND ACCESSORIES | 9 |
|---|---|---|

Use, operation and maintenance of fire service equipment's and accessories- Suction and delivery Hose, Hose reel, Hose fittings- coupling, adapters, branches, branch holders, radial branches, collecting heads, stand pipe, monitors, hydrants; Introduction to fire fighting vehicles and appliances- Pumps, primers, crash tenders, rescue tenders, hose laying tenders, control vans, hydraulic platforms; Ropes and Lines- Types-wire and rope lines used in fire service. Use and testing of lines, knots, Bends and hitches; General rope work.

| UNIT IV | FIRE STREAM PATH | 9 |
|---|---|---|

Fire stream-path, range; nozzles-types, calculation of discharge capacity, nozzle reaction; Hydraulic and energy grade lines, pressure loss or gain because of elevation, back pressure; friction losses in pipes, fire hoses and fixtures, parallel and series connections; Flow in pipes and fire hoses, branching lines; water relay techniques; Estimation of fire protection water requirements, pump capacity and other parameters relating to fire hydraulics.

| UNIT V | FIRE GROUND OPERATIONS AND SAFETY | 9 |
|---|---|---|

Fire ground operations - preplanning, action on arrival and control, methods of rescue, methods of entry.

Personnel safety. Control procedure and use of other safety equipment. Ventilation and salvage operations. Toxicity of smoke-effect of harmful agents preventing escape and causing injury of death-CO, $CO_2$, HCN, $SO_2$, $NH_3$.Nitrogen oxide.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | understand the theory of fire chemistry; learn about different kinds of combustion and their characteristics. | Understanding (K2) |
| CO2 | learn about the products of combustion-flame, heat, smoke, fire gases- and their characteristics. | Understanding (K2) |
| CO3 | acquire the knowledge about the use and operation of fire service equipment, machineries and accessories. | Applying (K3) |
| CO4 | calculate the water requirement and the pump capacity for fire fighting and understand the basic fire ground operations. | Analysing (K4) |
| C05 | learn different types of fire protection systems/ installations in oil and gas industry. | Understanding (K2) |

**TEXT BOOKS**


1. Gupta, R.S., "Hand Book of Fire Technology" Orient Longman, Bombay 2017.
2. William E Clark (Reprint 2015). Fire fighting principles & practices (2nd edn). Fire Engineering Books Videos.


**REFERENCES**


1. HMSO,"Manual of fireman ship-part 1 to 13". London,1991.
2. Jain V.K. "Fire safety in buildings" (2nd edn.). New Age International (P) Ltd., NewDelhi.2010.
3. Barendra Mohan Sen,"Fire protection and prevention the essential handbook", UBS publishers and Dist., New Delhi,2013.
4. "Fire Prevention and firefighting", Loss prevention Association, India.N F P A. Fire Protection Hand Book.20th Edition, 2008


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | - | - | 3 | 2 | - | - | - | - | 2 | 3 | 3 |
| CO2 | 3 | 3 | 2 | - | - | 3 | 2 | - | - | - | - | 2 | 3 | 3 |
| CO3 | 3 | 3 | 2 | - | - | 3 | 2 | - | - | - | - | 2 | 3 | 3 |
| CO4 | 3 | 3 | 2 | - | - | 3 | 2 | - | - | - | - | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | - | - | 3 | 2 | - | - | - | - | 2 | 3 | 3 |

| SF20252 | FIRE RISK ANALYSIS AND ACCIDENT INVESTIGATION | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | reduce work place hazards and to encourage the standard ofSafety health & environment programmed. |
| 2. | train and motivate in maintaining and improving the quality of the environment and Preventing and abating environment pollution. |
| 3. | create awareness about Fire safety and Fire prevention |
| 4. | educate how to reduce work place hazards and to encourage the standard ofSafety |
| 5. | familiarize with the design, installation, working and use of Different types of FireProtection systems |

| UNIT I | APPLICATION OF FIRE RISK ANALYSIS | 9 |
|---|---|---|

Basic field of application, Methods of application Probability Concept: Basic concept of Probability Theory, Independence and conditionality, Random Variables and Probability Distributions, Keyparameters of probability Distributions, Commonly used Probability Distributions.

| UNIT II | STATISTICS & EXTREME VALUE THEORY | 9 |
|---|---|---|

Introduction, Basic concept of statistical analysis, Key parameters of descriptive statistics, Correlation, Regression and Analysis of Variance, Hypothesis Testing in Classical Statistical Inference, Sampling Theory. Extreme Order Distribution, Behavior of Large Losses, Average Loss, Economic Value of Fire Protection Measures, Factor Affecting fire damages, Analysis of test results,Fire Severity and fire resistance.

| UNIT III | RELIABILITY | 9 |
|---|---|---|

Component Life, Failure Rate, Estimating the parameters of a Distribution, System Reliability, Bayesian Methods. Probability Models in Fire Protection Engineering: Decision Trees, Fault Trees, Markov Chains, Queuing Models of Fire Company Availability, Stress-Strength model in Fire Safety,Engineering Economics

| UNIT IV | UTILITY THEORY | 9 |
|---|---|---|

Utility, Utility Functions, Fire Protection and Insurance, Decision Analysis, Construction of Utility Function Value of Human Life: Methods of Valuing Human Life, Applications, Cost-Benefit Analysis, and General Decisions.

| UNIT V | COMPUTER SIMULATION FOR FIRE PROTECTION | 9 |
|---|---|---|

Engineering Computer Simulation Methodology, Tools of Simulation, Variance Reduction Techniques, Statistical Termination Tests, Flexibility versus Computation, Simulation Languages.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | apply concept of probability theory in fire analysis | Applying (K3) |
| CO2 | apply concept of factor affecting fire damages | Applying (K3) |
| CO3 | apply concept of Fire Protection Engineering | Applying (K3) |
| CO4 | apply concept of Fire Protection and Insurance | Applying (K3) |
| CO5 | apply concept of simulation software in calculations | Applying (K3) |

**TEXT BOOKS**

1. An introduction to fire dynamics – Dougal Drysdale, ISBN: 978-0-470-31903-1, August 2021
2. Enclosed Fire Dynamics – Bjorn karlsson, Jammes G Quintiere , Taylor & Francis group,28 September 2022

**REFERENCES**

1. "Fire Service Pump Operator-by IAFC"- J&B learning, 2013 edition
2. "Fire Service Hydraulics & Pump Operation"- Paul Spurgeon, Fire Engineering Series, Pen wellPublications.
3. Tariff Advisory Committee Book.
4. Fundamentals of Fire fighter skills-by IAFC"- J&B learning, 2013 edition

**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | - | - | - | - | 2 | 1 | - | 3 | - | 3 | 2 |
| CO2 | 3 | 3 | 3 | - | - | - | - | 2 | 1 | - | 3 | - | 3 | 3 |
| CO3 | 3 | 3 | 3 | - | - | - | - | 2 | 1 | - | 3 | - | 3 | 2 |
| CO4 | 3 | 3 | 3 | - | - | - | - | 2 | 1 | - | 3 | - | 3 | 2 |
| CO5 | 3 | 3 | 3 | - | - | - | - | 2 | 1 | - | - | - | 3 | 3 |

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| SF20253 | FIRE FIGHTING INSTALLATION AND AUTOMATION | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | familiarization and demonstration of fixed installation at visit to high rise building. |
| 2. | practical training about Care and maintenance of sprinklers |
| 3. | demonstration of different Automatic Fire Detection cum Alarm System |
| 4. | familiarization and demonstration mechanical foam installation. |
| 5. | fixed firefighting installations involving carbon di oxide and dry powder |

| UNIT I | INTRODUCTION | 9 |
|---|---|---|

Personal Protective Equipment : Need for Personal Protection Equipment, Selection, Use, Care & Maintenance Respiratory and Non-respiratory Personal Protective Equipment, Head Protection, Ear Protection, Face and Eye Protection, Hand Protection, Foot Protection, Body Protection. Standards & regulations

| UNIT II | FIXED FIRE FIGHTING INSTALLATION | 9 |
|---|---|---|

Introduction of Sprinkler System and their care and maintenance and operational Procedure, Elementary requirements of Drenchers, Rising Mains, Hose Reels And Down-comer, Fire pump control panel. Types of F FF Installations- water based, non-water based. Fixed Foam installation, Foam pours, foam makers, HVWS, MVWS ,Total flooding system $CO_2$, FM-200 etc.,

| UNIT III | AUTOMATIC FIRE DETECTION CUM ALARM SYSTEM: | 9 |
|---|---|---|

Introduction of Types of Detectors- Smoke, Heat, Flame/Gas Detectors, Operating principles, F.D.A. Panel M.C.P. & P.A. with talk back

| UNIT IV | MECHANICAL FOAM INSTALLATION | 9 |
|---|---|---|

Determination of foam compound for fire-fighting in oil tanks, Methods of application. Top application Base injection, Sub-surface Injection. Foam inlets and Risk for which foam is used. Premix foams, Installation characteristics of foam. Different types of foam, Low expansion, Medium expansion and High expansion foam, their special application, advantage and disadvantage of various types and the storage of foam concentrates.

| UNIT V | INSTALLATIONS INVOLVING CARBON-DI-OXIDE AND DRY POWDER | 9 |
|---|---|---|

Their special features, characteristics, designing, arrangements, operation, extinguishing action, risk and specification- Fire Alarm & Detection System: Designing, Calculations, Testing and Maintenance, Working principle of smoke detectors, heat detectors, Flame detectors & optical beam type detectors.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | identify and take necessary precautions on fire and safety hazards and report according to work policy and procedures. | Applying (K3) |
| CO2 | record accident details correctly according to accident/injury procedures. | Understanding (K2) |
| CO3 | identify, handle and store / dispose-off dangerous goods and substances according to policy and procedures following safety regulations and requirements | Applying (K3) |

| | | |
|---|---|---|
| CO4 | learn installation of firefighting mechanical foam installation. | Understanding (K2) |
| C05 | learn installations involving carbon di oxide and dry powder. | Understanding (K2) |

**TEXT BOOKS**

1. Introduction to Mathematical Fire Modeling, Second Edition ByMarcL. Janssens.
2. standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model by Joe H. Scott, Robert E. Burgan

**REFERENCES**

1. Handbook of fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical and Related Facilities- Dennis. P. Nolan
2. National Fire Protection Association Handbook
3. Hazards in Process Industries – Hidup Suatu Pendakian
4. Industrial Safety Management - N.K. Tara Fdar, K.J Tara Fdar

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | - | - | - | 2 | - | 1 | - | - | 3 | - | 1 | - | 2 | 2 |
| CO2 | - | 3 | - | 2 | 2 | 2 | - | 1 | 3 | 3 | 2 | - | 2 | 3 |
| CO3 | - | 1 | - | - | - | - | 2 | 3 | 3 | - | - | - | 2 | - |
| CO4 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | - | 3 | 1 |
| CO5 | - | 2 | 2 | 3 | - | - | - | - | 3 | - | - | 2 | 2 | 1 |

| SF20254 | FIRE PREVENTION AND PROTECTION MEASURES | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | study about the Planning and Construction of the building. |
| 2. | learn about the strategic points and selection of fire extinguishing device. |
| 3. | focus on Special safety protection equipment and Explosion detection. |
| 4. | design and analysis of especially smoke movement and control. |
| 5. | understand the Portable extinguishers and firefighting systems in industrial fire protection systems. |

| UNIT I | GENERAL PRINCIPLES OF FIRE PREVENTION AND PROTECTION MEASURES | 9 |
|---|---|---|

Planning and Construction of the building: Site planning considering the nature of the plant, building, equipment and process from the stand point of safety and fire protection, where corrosive, poisonous, explosive and easily combustible materials are handled and processed. Type of construction fire wall, barricades etc. Fire separation, fire steps, segregation, isolation.

| UNIT II | INTERNAL PLANNING AND COMBUSTION OF PLANTS AND BUILDINGS | 9 |
|---|---|---|

Layout of hazardous pipe lines, vessels and equipment, planning of strategic points and selection of fire extinguishing device, Automatic, fire doors, fire, doors, wire glass windows, fire walls, parapeted to prevent spread of fire through roofs, vertical cut offs, Exits, guard & guarding, floor platforms, path roadways, stairs ventilation. Protection and devices for fire due to lightening.

| UNIT III | FIRE PROTECTION ARRANGEMENT | 9 |
|---|---|---|

Fire appliances: Fire warning system (Manual & Automatic) fixed fire-fighting installations: Foam system; Gas/vapor system; Dry powder system; Special safety protection equipment-Explosion detection, venting and suppression system, Inergen clean agent system and F.M. 200. Different Extinguishing properties & application like water, foam, and carbon die oxide, dry chemical powder, halogenated agent and halon alternatives. Lighting: lighting arrangement and minimum light require in domestic, commercial, industrial and public assembly occupancies etc. Emergency lighting system.

| UNIT IV | SAFETY AND FIRE PROTECTION ORGANIZATION | 9 |
|---|---|---|

House-keeping and management; Plant fire brigade and fire fitting facilities, petrol, systems. Detailed analysis of fire case studies: especially those fires were large number of people have been involved. Interaction and relative value of the components of escape route design, especially smoke movement and control.

| UNIT V | INDUSTRIAL FIRE PROTECTION SYSTEMS | 9 |
|---|---|---|

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO2 system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers –flammable liquids – tank farms – indices of in flammability -fire fighting systems.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | understand the Fire separation, fire steps, segregation of different types of fire. | Understanding (K2) |
| CO2 | identify the effect of the product of combustion and their characteristics. | Applying (K3) |
| CO3 | understand the basic concepts of fire as a chemical reaction, the major phases of fire, and the main factors that influence fire spread and fire behavior. | Understanding (K2) |
| CO4 | identify the types of common fire department apparatus, equipment, and personal safety equipment used for firefighting. | Applying (K3) |
| CO5 | know the detail about special fire suppression systems like deluge and emulsifier. | Understanding (K2) |

**TEXT BOOKS**

1. J.J. Williams - "General fire hazards and fire protection", Routledge, 7th Edition, 2008.
2. F.P.A. - "Fire prevention Notes for Industrial premises", Butter worth-Heinemann publications, 4th Edition 2012.

**REFERENCES**

1. "Fire prevention standard" recommendations by Earnest Beam Ltd, J&B learning, 2013, 6th Edition.
2. Warre J. Baker - Automation- "A challenge to fire protection Engineers". Fire Journal, NFPA, Reprint 2018, 2nd Edition.
3. "Mather and Platt" - Fire Protection- Technical information and Useful general knowledge, Butterworth Heinemann, first published 1996.
4. H.N.S.O - "Fire protection in factory, buildings", Fire Tech.3 (2017).

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 1 | - | - | - | - | - | - | - | 1 | - | 2 | - |
| CO2 | - | 1 | 3 | - | 1 | - | - | - | - | - | 2 | - | 2 | 1 |
| CO3 | - | - | 2 | - | 3 | - | - | - | - | - | 1 | - | 3 | 1 |
| CO4 | - | 3 | 2 | - | - | - | - | - | 1 | - | - | 2 | 2 | 2 |
| CO5 | - | - | - | - | 1 | - | - | 1 | 2 | - | - | - | 3 | 3 |

| SF20901 | ENERGY CONSERVATION AND MANAGEMENT | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | understand and analyses the energy data of industries |
| 2. | carryout energy accounting and balancing |
| 3. | conduct energy audit and suggest methodologies for energy savings |
| 4. | utilise the available resources in optimal ways |
| 5. | learn how to calculate and apply discount rates in energy project analysis. |

**UNIT I INTRODUCTION** 9

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II ELECTRICAL SYSTEMS** 9

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III THERMAL SYSTEMS** 9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories.

**UNIT IV ENERGY CONSERVATION IN MAJOR UTILITIES** 9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets.

**UNIT V ECONOMICS** 9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept.

**TOTAL PERIODS: 45**

| **COURSE OUTCOMES** At the end of the course, the students will be able to | | **BT MAPPED** (Highest Level) |
|---|---|---|
| CO1 | remember the knowledge for basic combustion and furnace design and selection of thermal and mechanical energy equipment | Remembering (K1) |
| CO2 | study the theoretical air required for complete combustion. | Understanding (K2) |
| CO3 | skills on combustion thermodynamics and kinetics | Applying (K4) |
| CO4 | apply calculation and design tube still heaters | Applying (K3) |
| C05 | study the different cost analysis and discount rate. | Understanding (K2) |

**TEXT BOOKS**

1. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2014.

2. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London Reprint, 2016.

**REFERENCES**


1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 2017.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 2017.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, Reprint, 2017.
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 2018.


**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | - | 2 | 3 | - | - | - | - | - | - | - | - | 2 | 1 |
| CO2 | 3 | - | 2 | 3 | - | - | 2 | 3 | - | - | - | - | 2 | 2 |
| CO3 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 |
| CO4 | 3 | - | 3 | 2 | - | - | - | 3 | - | - | - | - | 3 | 1 |
| CO5 | 3 | - | 3 | 3 | - | - | - | - | - | - | - | - | 2 | 1 |

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| SF20902 | AIR POLLUTION AND CONTROL ENGINEERING | 3 | 0 | 0 | 3 |
|---|---|---|---|---|---|

**COURSE OBJECTIVES**

To enable the students to

| | |
|---|---|
| 1. | understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management |
| 2. | identify, formulate and solve air and noise pollution problems |
| 3. | design stacks and particulate air pollution control devices to meet applicable standards. |
| 4. | select control equipment. |
| 5. | ensure quality, control and preventive measures. |

| UNIT I | HISTORY, SOURCES AND EFFECTS OF AIR POLLUTION | 9 |
|---|---|---|

Air Pollution- Definition, Sources, Types and classification, Its effect on human health, vegetation, materials and properties, Air pollution Episodes and lesson learnt, Global effects: Global Warming and Cooling, Acid Rain, Dust dome effects and Heat Island effect, Ozone Layer Depletion.

| UNIT II | METEOROLOGY AND AIR POLLUTION | 9 |
|---|---|---|

Introduction to Meteorology- factors influencing air pollution, Lapse rates, Atmospheric stability conditions and temperature inversions, Plume behavior, Maximum Mixing Depths, Effective Stack height, Types of dispersion models: Gaussian model - Introduction, Dispersion Equation for Point Source at GL.

| UNIT III | CONTROL OF PARTICULATE CONTAMINANTS | 9 |
|---|---|---|

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

| UNIT IV | CONTROL OF GASEOUS CONTAMINANTS | 9 |
|---|---|---|

Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

| UNIT V | INDOOR AIR QUALITY MANAGEMENT | 9 |
|---|---|---|

General Methods of Control of NOx and SOx emissions – In-plant Control Measures, process changes, dry and wet methods of removal and recycling. Air Quality Management – Monitoring of SPM, SOx; NOx and CO Emission Standards.

| | TOTAL PERIODS: | 45 |
|---|---|---|

| COURSE OUTCOMES<br>At the end of the course, the students will be able to | | BT MAPPED<br>(Highest Level) |
|---|---|---|
| CO1 | understands nature and characteristics of air pollutants | Understanding (K2) |
| CO2 | measure and estimate the emissions from stationary (e.g. factory) and mobile (e.g. cars) sources. | Applying (K3) |
| CO3 | differentiate between the general and modern techniques used to control and reduce amount of gaseous emissions in the atmosphere. | Analysing (K4) |
| CO4 | learn the effective methods used to control particulate matter | Understanding (K2) |
| CO5 | understands air quality management | Understanding (K2) |

**TEXT BOOKS**

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science + science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.

**REFERENCES**

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution",Tata Mcgraw Hill Publishing Company limited,2007.

**CO - PO MAPPING**

Mapping of Course Outcomes with Programme Outcomes:
**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | - | - | - | 2 | - | 1 | - | - | 3 | - | 1 | - | 2 | 1 |
| CO2 | - | 3 | - | 2 | 2 | 2 | - | 1 | 3 | 3 | 2 | - | 2 | - |
| CO3 | - | 1 | - | - | - | - | 2 | 3 | 3 | - | - | - | - | 3 |
| CO4 | - | - | - | 3 | - | - | - | 2 | 3 | - | - | - | - | 1 |
| CO5 | - | 2 | 2 | 3 | - | - | - | - | 3 | - | - | 2 | 2 | 1 |